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COMPLIMENTS OF
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Relation Between Retinal Hemorrhages and High Arterial Pressure*

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In following the reasoning usually given that there is a degeneration of the vessel wall from an accompanying anemia, or as a result of toxic influences, as chemical poisons or venoms, introduced into the system, or autogenous metabolic products, the result of a faulty body chemistry, we have been led to believe that these are merely predisposing factors, whereas the true or exciting cause of these hemorrhages in a very large proportion of the cases is a sudden, transient or a persistent, abnormal elevation of the arterial blood pressure.

Structures containing end arteries, as the eye, brain or kidney, with their usual delicate capillary endings, are least capable of withstanding this type of a lateral strain imposed upon their walls.

An examination of the literature upon the subject shows that attention had been briefly called to this phenomenon as a cause of retinal hemorrhages twenty-five years ago by Mackenzie and Watson, who

studied these cases imperfectly with the sphygmograph; also, more recently, by Dr. E. W. Stevens and Dr. Melville Black, of Denver*.

That this is an etiologic factor, we believe to be partially established by our researches in this particular field during the past two or three years. The studies of the blood pressure, blood and urine of one hundred cases was decided upon to be investigated with this end in view. The patients examined were those seen within the first forty-eight hours following the hemorrhage, the larger number, however were observed within twelve hours of the onset. In all cases the blood pressure was estimated with the Stanton modification of the Riva-Rocci sphygmomanometer with a 9 cm. cuff. The estimations were made either in the sitting posture with the arm elevated to the level of the heart, or in the supine position with it bearing the same relation to that organ. The systolic pressure only is recorded, as it represents the greatest pressure the vessels were called upon to withstand. A complete blood count and an analysis of the urine, with particular reference to the presence of albumen, glucose or casts,

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was made in each case. The necessary data in the history and physical examination were then considered in order to determine the predominant factors essential in making a general diagnosis, irrespective of the ocular condition.

The thought, which was responsible for these investigations, was therefore an effort to prove this new field of vascular study, namely, the systematic estimation of the arterial blood pressure, as having both an etiologic and therapeutic relation to hemorrhages of the conjunctiva and retina. The blood pressure should be carefully and immediately studied in this class of ophthalmic cases, first, with a view to determining the presence of one of the most frequent causal conditions; secondly, to permit us to intelligently direct the treatment toward absorption of the existing clot and the prevention of further

hemorrhages. It is thus, by this timely interference, that many years of vision and even life may be saved these individuals. They are often, as most of us know, quite robust and enjoying the best of health in so far as their knowledge goes, and only in the latest stages, when tangible subjective symptoms appear, can they be persuaded to relinquish their activities and excesses. The oculist, therefore, often being the first physician to be consulted, should study these patients with the internist, in order that the most comprehensive knowledge possible should be available for the sufferer.

The tabulated results of the investigations of one hundred consecutive cases, derived from private and dispensary practice, are herewith subjoined; the number, although not large, we consider sufficient to illustrate our premises.

Case	Age	Ocular Diagnosis	Blood Pressure, Mm.	Hemaglobin, Per Cent	Blood—R. B. C.	W. B. C.	Urine	General Diagnosis
1	58	Hemorrhagic retinitis	158	70	4,100,000	7,200	Albumin, trace No casts	Arterio-sclerosis
2	35	Hemorrhagic retinitis. Choked disc	240	80	3,960,000	7,000	Albumin and casts	Chronic parenchymatous nephritis
3	46	Anemia of retina	152	70	3,200,000	6,800	Negative	Secondary anemia
4	52	Hemorrhagic retinitis Subconjunctival hemorrhage	178	85	4,040,000	7,000	Albumin No casts	Interstitial nephritis
5	56	Retinal hemorrhages	240	50	3,740,000	7,800	Albumin and casts	Interstitial nephritis
6	34	Albuminuric retinitis	120	62	4,120,000	7,600	Albumin and casts	Chronic parenchymatous nephritis
7	36	Subconjunctival hemorrhages	110	73	5,930,000	4,800	Negative	Chloro-anemia
8	52	Albuminuric retinitis	212	78	4,030,000	7,200	Albumin and casts	Chronic interstitial nephritis



Case	Age	Ocular Diag- nosis	Blood Pressure, Mm...	Hemaglobin, Per Cent.	Blood—R. B. C....	W. B. C.....	Urine	General Diag- nosis
9	38	Retinal asthenopia and hemorrhages	160	68	2,810,000	5,000	Negative	Pernicious anemia (?)
10	54	Arterio-sclerosis of retinal vessels	215	78	4,120,000	6,800	Albumin Few casts	Arterio-sclerosis
11	36	Tumor of orbit	105	85	5,960,000	6,400	Negative	Orbital tumor
12	58	Hemorrhagic retinitis	136	90	4,390,000	5,600	Negative	Arterio-sclerosis
13	35	Hemorrhagic retinitis	110	76	3,840,000	5,800	Negative	Anemia and intestinal auto- toxemia
14	53	Subconjunctival hemorrhage	230	90	6,050,000	5,000	Albumin Few casts	Interstitial nephritis
15	48	Diabetic hemorrhages Retinitis	120	90	5,350,000	7,200	Glucose	Diabetes
16	38	Edema of retina	110	95	5,050,000	7,400	Negative	Intestinal auto- intoxication
17	45	Subconjunctival hemorrhage	160	84	4,120,000	7,600	Albumin and casts	Early interstitial nephritis
18	57	Albuminuric retinitis Hemorrhages	155	92	5,060,000	6,500	Albumin and casts	Advanced inter- stitial nephritis
19	29	Retinal hemorrhages Double choked disc	135	85	4,020,000	8,000	Negative	Syphilis
20	58	Retinal hemorrhages	142	80	3,910,000	7,400	Albumin Negative Hyalin casts	Interstitial nephritis
21	78	Hemorrhage of right macula	170	75	4,800,000	7,2000	Albumin No casts	Senile arterio- sclerosis
22	46	Anemia of retina Old hemorrhages	152	67	3,650,000	6,000	Albumin No casts	Symptomatic anemia
23	49	Albuminuric retinitis	135	85	4,420,000	7,200	No albumin Casts	Interstitial nephritis
24	54	Hemorrhagic retinitis	236	80	4,200,000	7,400	Albumin Casts	Interstitial nephritis
25	43	Albuminuric retinitis	190	83	4,620,000	8,000	Albumin and casts	Secondary con- tracted kidney
26	36	Subconjunctival hemorrhage	135	90	4,700,000	7,800	No albumin Casts	Kidney of preg- nancy
27	32	Albuminuric and hem- orrhagic retinitis	193	85	5,010,000	7,200	Albumin and casts	Chronic paren- chymatous nephritis

Case	Age	Ocular Diag- nosis	Blood Pressure, Mm...	Hemaglobin, Per Cent.	Blood—R. B. C....	W. B. C.....	Urine	General Diag- nosis
28	30	Hemorrhagic retinitis	125	75	4,570,000	8,000	Negative	Secondary anemia, over- work and exhaustion
29	48	Hemorrhagic retinitis	166	72	4,730,000	9,000	Albumin, casts	Interstitial nephritis
30	52	Albuminuric retinitis	225	60	3,400,000	6,600	Albumin and casts	Late stage inter- stitial nephritis
31	34	Anemia of retina with small hemorrhages	130	65	2,510,000	130,000	Albumin No casts	Leukemia
32	64	Hemorrhagic retinitis	204	60	4,350,000	7,400	Albumin and casts	Chronic inter- stitial nephritis
33	45	Hemorrhagic retinitis	220	82	4,110,000	7,600	Albumin and casts	Chronic inter- stitial nephritis
34	36	Ocular headache, sub- conjunctival hemorrhage	122	83	4,180,000	7,400	Oxaluria	Lithemia
35	64	Retinal hemorrhage	106	92	5,001,000	7,600	Albumin No casts	Arterio-sclerosis
36	54	Subconjunctival hem-	178	96	4,992,000	8,200	Albumin No casts	Arterio-sclerosis
37	37	Subconjunctival hem- orrhage	142	78	5,001,000	7,600	No albumin or casts Uric acid	Lithemia
38	47	Subconjunctival hem- orrhage	170	90	4,060,000	7,400	Albumin and casts	Arterio-sclerosis
39	44	Subconjunctival hem- orrhage	160	85	4,120,000	8,000	Albumin and casts	Chronic paren- chymatous nephritis
40	42	Hemorrhagic retinitis	152	88	4,200,000	7,800	Albumin No casts	Retinal and gen- eral arterio- sclerosis
41	58	Albuminuric retinitis	158	70	3,980,000	8,000	Albumin and casts	Arterio-sclerosis
42	59	Subconjunctival hem- orrhage	149	84	4,010,000	6,500	Albumin and casts	Chronic inter- stitial nephritis
43	62	Sclerosis of retinal vessels	162	95	4,832,000	6,800	Albumin No casts	Arterio-sclerosis and presenility
44	29	Albuminuric retinitis	148	82	4,100,000	7,600	Albumin and casts	Chronic paren- chymatous nephritis
45	72	Unilateral retinal hemorrhages	232	80	3,720,000	7,200	Albumin and casts	Arterio-sclerosis and arterio- sclerotic kidney

Case	Age	Ocular Diag- nosis	Blood Pressure, Mm...	Hemoglobin, Per Cent.	Blood—R. B. C....	W. B. C.....	Urine	General Diag- nosis
46	36	Colloid degeneration of arterial vessels	132	68	3,840,000	4,800	Albumin, a trace Casts, a few	Beginning renal degeneration
47	45	Retinal hemorrhage	144	82	4,120,000	6,800	Albumin (?) No casts	Early arterio- sclerosis
48	42	Macular hemorrhage	136	88	4,020,000	7,200	Albumin No casts	Early cirrhotic kidney
49	54	Retinal hemorrhages	255	55	3,640,000	6,800	Albumin and casts	Chronic inter- stitial nephritis
50	63	Silver wire retinal vessels	140	75	4,114,000	6,200	Albumin No casts	Arterio-sclerosis
51	56	Retinal congestion, slight hemorrhages and edema.	148	92	5,001,000	7,400	No albumin No casts	Passive cerebral congestion, result of aneurysin
52	36	Subconjunctival hem- orrhages	144	94	4,020,000	7,800	No albumin No casts Uric acid	Lithemic hyper- tension progress- ing toward cir- rhotic kidney
53	33	Albuminuric retinitis	122	60	3,812,000	6,800	Albumin and many casts	Chronic paren- chymatous nephritis
54	53	Albuminuric retinitis	264	76	4,020,000	7,200	Trace of albumin Few casts	Chronic inter- stitial nephritis
55	46	Diabetic hemorrhagic retinitis	110	84	4,760,000	7,400	Glucose present Albumin and casts Negative	Diabetes
56	44	Hemorrhagic retinitis	185	90	4,328,000	7,200	Albumin, none Casts, none	Sudden vascular rupture under excitement in case of early atheroma
57	66	Cataract and conjunc- tival hemorrhage	164	66	3,600,000	5,400	Albumin present Casts present	Chronic inter- stitial nephritis
58	43	Retinal hemorrhages	232	95	5,100,000	7,800	Albumin + and casts present	Chronic inter- stitial nephritis
59	46	Retinal hemorrhages	260	75	5,340,000	11,000	Albumin and casts present	Chronic inter- stitial nephritis Reduced pressure to 180
60	27	Recurrent iritis and retinal hemorrhage	126	90	4,800,000	7,200	Albumin and casts	Specific iritis
61	40	Retinal hemorrhage	188	88	4,621,000	7,800	Albumin, trace Casts negative	Arterio-sclerosis

Case	Age	Ocular Diag- nosis	Blood Pressure, Mm...	Hemaglobin, Per Cent.	Blood—R. B. C....	W. B. C.....	Urine	General Diag- nosis
62	58	Retinal hemorrhage	178	90	4,392,000	8,000	Albumin, none Casts, none	Arterio-sclerosis
63	50	Retinal hemorrhage	148	87	4,862,000	7,600	Albumen, trace No casts	Interstitial nephritis
64	63	Glaucoma. Subcon- junctival hemorrhages	225	96	5,010,000	8,200	Albumin, trace Few casts	Glaucoma and interstitial nephritis
65	59	Retinal hemorrhage	265	90	4,110,000	7,600	Albumin and casts	Interstitial nephritis
66	69	Retinal hemorrhage	195	69	3,800,000	7,200	Albumin, excess Casts numerous	Moderate cardiac dilatation Chronic nephritis
67	38	Retinal hemorrhages	160	76	4,160,000	7,600	Albumin, trace Few casts	Chronic nephritis
68	45	Retinal hemorrhage	195	94	4,980,000	7,800	Albumin, trace No casts	Arterio-sclerosis
69	54	Retinal hemorrhage	212	91	4,001,000	7,600	Albumin, trace Casts few	Chronic inter- stitial
70	54	Retinal hemorrhage	226	95	4,872,000	7,200	Albumin, trace Few hyalin	Chronic inter- stitial
71	58	Hemorrhagic retinitis	164	72	4,211,000	8,000	Albumin, trace Few casts	Arterio-sclerosis
72	36	Hemorrhagic retinitis Choked disc	242	83	4,480,000	7,600	Much albumin Many casts	Chronic paren- chymatous nephritis
73	53	Retinal and subcon- junctival hemorrhages	179	86	4,040,000	7,400	Albumin, trace Few casts	Interstitial nephritis
74	57	Hemorrhagic retinitis	243	54	3,622,000	6,200	Albumin and casts	Interstitial nephritis
75	36	Albuminuric Hemor- rhagic retinitis	144	62	3,921,000	6,800	Albumin and casts	Chronic paren- chymatous nephritis
76	54	Arteriosclerosis of reti- nal vessels. Small hem- orrhages	215	78	4,013,000	7,400	Albumin, trace Few casts	Interstitial nephritis
77	60	Hemorrhagic retinitis	130	92	4,382,000	5,600	Albumin, trace No casts	Arterio-sclerosis
78	52	Subconjunctival hemorrhages	234	94	5,020,000	5,800	Albumin Few casts	Interstitial nephritis
79	46	Subconjunctival hemorrhage	164	85	4,320,000	7,600	Albumin, trace Occasional casts	Early interstitial nephritis

Case	Age	Ocular Diag- nosis	Blood Pressure, Mm...	Hemaglobin, Per Cent.	Blood—R. B. C....	W. B. C.....	Urine	General Diag- nosis
80	79	Macular hemorrhage	178	78	3,900,000	6,200	No albumin Few casts	Senility, arterio- sclerosis
81	54	Retinal hemorrhages	235	81	4,196,000	8,000	Albumin, trace Many casts	Chronic inter- stitial nephritis
82	31	Albuminuric and hem- orrhagic retinitis	1944	86	4,680,000	7,200	Much albumin Many casts	Chronic paren- chymatous nephritis
83	65	Hemorrhagic retinitis	232	62	3,420,000	6,600	Albumin Many casts	Advanced inter- stitial nephritis
84	64	Hemorrhagic retinitis	168	86	4,021,000	6,800	Albumin No casts	Arterio-sclerosis
85	38	Subconjunctival hemorrhage	144	78	5,010,000	7,200	No albumin or casts Uric acid	Lithemia
86	43	Retinal hemorrhage	153	87	4,121,000	8,000	Albumin, trace No casts	Early arterio- sclerosis
87	71	Retinal hemorrhage	230	81	3,890,000	4,800	Albumin, trace	Arterio-sclerosis and arterio- sclerotic kidney
88	55	Retinal hemorrhage	255	61	3,640,000	6,800	Albumin and casts	Chronic inter- stitial nephritis
89	57	Retinal hemorrhage	184	64	3,890,000	7,200	Albumin and casts	Chronic inter- stitial nephritis
* 90	28	Albuminuric retinitis	146	73	4,001,000	7,600	Much albumin Many casts	Chronic paren- chymatous nephritis
91	57	Retinal hemorrhage	156	96	5,010,000	8,000	Albumin, faint trace No casts	Arterio-sclerosis
92	33	Albuminuric and hem- orrhagic retinitis	124	72	3,920,000	7,800	Much albumin Many casts	Chronic paren- chymatous nephritis
93	44	Hemorrhagic retinitis	184	88	4,231,000	7,200	Albumin negative Casts few	Early arterio- sclerosis
94	67	Subconjunctival hemorrhage	165	68	3,920,000	7,400	Albumin present Few casts	Chronic inter- stitial nephritis
95	43	Retinal hemorrhage	228	84	4,200,000	7,600	Albumin and casts present	Chronic inter- stitial nephritis
96	47	Retinal hemorrhage	196	89	4,021,000	8,000	Albumin, trace Casts numerous	Early arterio- sclerosis. Cirrhotic kidney
97	54	Retinal hemorrhage	218	92	4,211,000	6,800	Albumin, trace Casts few	Chronic inter- stitial nephritis
98	50	Retinal and subcon- junctival hemorrhage	152	90	4,078,000	9,000	Albumin, trace No casts	Generalized arterio-sclerosis

Case	Age	Ocular Diagnosis	Blood Pressure, Mm.	Hemoglobin, Per Cent.	Blood—R. B. C....	W. B. C.	Urine	General Diagnosis
99	31	Albuminuric and hemorrhagic retinitis	148	66	4,112,000	8,200	Albumin excessive. Numerous casts	Chronic parenchymatous nephritis
100	63	Retinal hemorrhage	229	97	4,820,000	7,800	Albumin, trace Casts numerous	Chronic interstitial nephritis

Eighty per cent. of the above cases occurred in diseases in which hypertension is the rule, and, if not a constant accompaniment, the cardiac hypertrophy present would be sufficient under extreme exertion or emotion the arterial pressure to become decidedly elevated.

By far the largest percentage of retinal hemorrhages were found in chronic interstitial nephritis—40 per cent.; arteriosclerosis second, with 27 per cent., and chronic parenchymatous nephritis third, with 13 per cent. The figures are suggestive in that it is to diseases of the kidney first, and of the arteries secondly, that our attention should be directed when seeking the cause of a given case of retinal apoplexy.

This series will also serve to clarify existing knowledge upon the relative frequency of occurrence of these various causes which are usually merely listed in most text books, without reference as to which organ or system should be investigated first.

Anemia—simple, pernicious, and leukemic, made up 6 per cent. of our cases, there being one case of spleno-myelogenic leukemia, in which hemorrhage is rather uncommon, and one early case of pernicious anemia.

In all but one instance there were hemorrhages of some type and the blood pressure, with one exception, was subnormal.

Singularly, the cases of lithemia, 4 per cent., revealed only subconjunctival hem-

orrhages; in none was it possible to determine the presence of even minute retinal hemorrhages. A moderate degree of hypertension for the age was the rule.

In two instances no other diagnosis could be made, but that of intestinal auto-intoxication, there being vertigo, persistent drowsiness, and an excess of indican and skatol found in repeated urinalyses. Both were examples of hypertension; one showed hemorrhage, the other edema of the retina.

Diabetic retinitis, with hemorrhages, furnished two cases. In both the blood pressure was subnormal; they belonging to the toxic group of causes of retinal apoplexy.

Secondary syphilis, a comparatively rare cause of these hemorrhages, was the etiologic factor in two instances. On one, there was an accompanying iritis; on the other, beginning choked disc; in neither was the arterial pressure unduly high. The single instance in which aneurysm was apparently the only ascertainable cause, failed to manifest any abnormality of blood pressure, blood, or the kidneys.

I am sure that increased arterial pressure is an important factor in the causation of acute glaucoma. It may be interesting to know that in one case of acute glaucoma, where the blood pressure was 265 cubic mm., twenty ounces of blood was taken from the right arm, when the pressure fell to 150 cubic mm. This patient had an attack of acute glau-

coma in the right eye two years before. An iridectomy was performed by a skilled operator, but it was not successful. The blood pressure was evidently so high that the eye was lost by an immediate intra-ocular hemorrhage and collapse of the eyeball. When the patient came under my care for a similar attack in the left eye, with tension $+3$ and over, and vision gone for two days, I concluded that a reduction of tension of the eyeball must be obtained somehow before a successful iridectomy could be hoped for. The patient being at this time without light perception. Eserine had failed to make any impression on the dilated pupil, or tension of the eyeball whatsoever. It was interesting to note the condition of the pupil after ten ounces of blood had been drawn from the arm; it commenced to contract, and by the time twenty ounces were taken and tension fell to 150 cubic mm., the pupil contracted to a pinhole and the tension of the eyeball was about normal. I was then able to perform an iridectomy without any untoward result, and useful vision followed. I am positive that by reducing, first the arterial pressure from 265 cubic mm. to 150 cubic mm., and secondly, giving the eserine an opportunity to act mechanically in aiding the reduction of the tension of the eyeball, I succeeded with the operation, whereas otherwise I should have probably failed.

Treatment—This subject will be considered only with reference to the departures from the usual line of therapy pursued in this class of cases. In those cases wherein the pressure was found to be abnormally high, in addition to rest, exclusion of light and the usual local measures, we found that absorption of the clot occurred far more rapidly (from one to three weeks sooner) by employing the following method:

All plethoric cases, with greatly increased arterial tension, were admitted

to the hospital and immediately bled from the median basilic vein, following the technic usually employed in venesection for any other condition.

The sphygmomanometer was adjusted to the opposite arm and the pressure recorded every minute. It was found that it was rarely necessary to reduce it lower than 110 mm. to 120 mm. for those with original pressure from 150 to 200 mm. Cases presenting systolic pressure of 200 mm. or over were seldom reduced lower than 150 mm. We were often compelled to desist before these reductions occurred, owing to faintness of the patient.

In the less robust, somewhat anemic cases, we practiced relieving hypertension with the aid of hot air baths, electric light baths or even hot packs with caution. This was found to be nearly as effectual as bleeding in hastening absorption and the restoration of function of the affected eye. In the obese, and when, for any reason, bleeding was refused, or impractical, thyroid extract, gr. ij., t. i. d., was of considerable use as a vasodilator and to diminish the viscosity of the blood. The above methods, while partially satisfactory, did not tend to produce the freedom from recurrence, which characterized the cases upon which venesection was performed. A number of chronic nephritics, with whom retinal hemorrhages had been habitual for months, have been entirely free from attacks during the past two years following this treatment. Although within the twenty-four hours following the bleeding the blood pressure recorded was higher than the elevation taken previous to venesection, there would be a daily decline of approximately 10 mm. per day for three or four days, which latter pressure would usually be maintained for several weeks, at least as long as our observation continued. The routine treatment, after patient left the hospital, would be carefully regulated, nitrogenous

intake, alkaline waters freely, and warm baths, 110°, for ten minutes, thrice weekly. Medicinal arterial relaxants were used, as sodium iodide gr. v. in conjunction with sodium nitrate, gr. j., three times daily for three weeks of each month, omitting every fourth week. In those cases with markedly hemorrhagic tendencies, as where there were both subconjunctival and retinal extravasations, gallic acid gr. x., three or four times daily, was added to other measures. Hydrargyri cum creta gr. j., t. i. d., was used in the autotoxic cases, and where the liver and intestinal

tract seemed to be principally at fault.

The cases of primary and symptomatic anemia, diabetes and syphilis were, of course, not treated by venesection.

CONCLUSIONS.

1st. A large proportion, 80 per cent., of retinal hemorrhages, occur in individuals suffering from a temporary or permanent high arterial blood pressure.

2d. This excessive intravascular pressure is apparently the most frequent exciting cause of these hemorrhages.

3d. Venesection has proven of value, not only in reducing dangerously high pressure, but in acting as a powerful stimulus to a speedy absorption of the clot.

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